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AND

MECHANICS' MAGAZINE.

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It is a common remark, that those subjects which appear most familiar, are those upon which we have least accurate information. Railroads are striking illustrations of this, at least as far as the non-professional public are concerned. It is true that a few general notions are current, but these are rather poetical representations of what Railroads ought, or are to be, rather than correct delineations of the actual state of the system. To those who, from the duties of their profession, or from constant intercourse with well-informed persons, are familiar with the subject, it may appear that we have underrated the amount of popular intelligence in regard to Railroads—but an attentive examination will prove that our statement is correct. The daily papers, although in some instances affording praiseworthy exceptions, are generally far too inaccurate in their general notices, while a conversation with Railroad Directors themselves will often confirm us in the opinion that sound information is often most scarce where it is most needed. But the best evidence of the truth of our position is to be found in the avidity with which the most erroneous statements are copied and promulgated without any correction, and sometimes with the most fulsome praise of the "soundness of the views," the "happy generalizations," etc.

We have been led to these remarks by observing the effect of an article on the "Railroads of the United States," published some time since in "Hunt's Merchants' Magazine," a journal in general remarkable for the accuracy and usefulness of the information it contains. This article, upon which we intend making some comments, has been extensively noticed, without (as far as we have known) a single correction, and in two instances has been, in part,

literally copied into the columns of daily papers as editorial, and in once case without even noticing the source whence it was taken. This was more remarkable, as the portion extracted contained the chief errors of the original.

The article in question contains a rather turgid, but tolerably correct, view of the capabilities and prospects of the Railroad system. The outline of the grand routes, either projected or executed, is correct in its statements, and decidedly good. But what we most seriously object to, and, unfortunately, the very portion which has attracted most notice, is a general view of the *great expense* and *unprofitableness* of Railroads. We give the passage entire. The Italics are our own.

"As regards the productiveness of Railroads, thus far, in the United States, to their stockholders, be they States or individuals, it is clear that as yet they have in general yielded but little profit, considering the amount of their cost. This cost is depending, of course, upon various local circumstances, such as the configuration of the territory through which they pass, the amount of excavation required, and the rocky or mellow nature of the soil. But even establishing the fact, which must be conceded by everybody, that railroads must occupy the place of ordinary roads, still the population of the country must grow much more dense; production, trade, commerce, and transportation, must be much augmented before they can all be very profitable sources of investment. *Their cost is generally great.* Besides the expense of making the ground nearly level wherever they pass, which is not required in ordinary roads, the construction of tunnels through solid rocks, and of throwing viaducts across rapid streams, a firm foundation must be made along the whole line of their tracks, either of wood or stone, wrought out at considerable cost. *These tracks must, moreover, be bound in a continuous line with thick bars of iron, cast in a peculiar form*, and up to this period, for the most part imported from abroad. To this may be added the expense of the engines, which is not generally less than several thousands of dollars; the passenger cars, which are constructed with great beauty, and enriched with the same adornments that are required in the most costly private saloon; the wages of experienced engineers, and their attendants; and the sum paid to individuals for the *user* of the land through which they pass, and for the wood which propels their engines. It must be evident that the cost of these tracks, running through long lines of distance, must in a short time be accumulated to a large sum, and a great amount of travel must be required, even to pay their expenses. *Yet it is well known, that only a few lines of railroads in the United States have yielded dividends to their stockholders.* It is to be hoped, however, that one important item will be saved by the non-importation of iron from abroad, as mountains of that mineral now slumber upon our land, inviting the pickaxe of the miner.

It would be unnecessary to point out to the professional reader the errors of this paragraph, did we not desire to embrace the opportunity of insisting upon the duty of Engineers to render the public a service, and advance the character of their own profession, by more frequent communications in our daily papers, and other journals intended for popular circulation.

It is well known, to Engineers, if not to financiers, that some of the best stocks now in the market are those of Railroads, which have never been down to par since their completion. The readers of the Railroad Journal have been so frequently presented with illustrations of this important fact, that they need not to be convinced of what is already so evident.

The next passage which we quote is a fair sample of the general style of the article.

"The next consideration which naturally comes before the mind in measuring the advantages of railroads, compared with other means of transportation, is their danger, contrasted with other roads. To be driven along through plains and valleys, sometimes within three inches of jaggy points of rock, at the rate of twenty-five miles an hour, (but more generally at the rate of fifteen miles,) often verging near the borders of deep rivers or steep ravines, by the power of strong engines, which, if they should run off their narrow track, would be as unmangeable as the steed of Mazeppa, and much more terrific in their struggles, is a matter, the danger of which is to be well weighed, before it is quietly submitted to; and in order to adjudge the risk, we only have to compare it with that of ordinary roads. The common roads, it is well known, cannot be travelled without the chances of accident, attended with injury. For example, the common road is often rough, and filled with obstacles; the carriage to which the horse is attached may break down or be upset; or the buckles and straps which confine him may give way and affright the animal; or the carriage, placed high upon its axle, may be overturned. On the other hand, the railroad cars, which in England ordinarily travel twenty-five miles an hour, and in this country sixteen miles, are, in the first place, perhaps, more dangerous from this very momentum. The boiler may explode, the car run off its track, or a mischievous boy may place an obstacle which will obstruct the passage of the cars, or remove one of the bars; the train may crash against the points of rock that constitute the walls of its tunnels, or rush off one of the steep embankments which border it. Yet the engines, boiling with ambition, and seemingly with rage, have no latent passions, like those of the frightened or maddened horse; the track is a level track, easily to be coursed by the naked eye, for a long distance, and the engines are usually provided with large shovels, which throw off from the path any obstacle which might oppose its progress. Besides, the engine at full speed can be stopped, at the distance of two hundred yards; and even were the cars de-

molished by concussion, the train behind would, if it kept upon the track, sustain only a temporary shock or delay. But we have accurate data of the actual amount of the loss of life by railroads in England, from well authenticated official reports, running down to November of 1838; and from these reports it appears that in that country there have been only ten passengers killed, out of forty-four millions transported,"

It is much to be regretted that, in treating a subject which requires the plainest language and the strictest adherence to fact, so much poetical imagery should have been used. There is, and there has been, no greater enemy to the cause of internal improvement than the unbounded exaggeration which has characterized the language of those who, without knowing much of the matter, have ventured to say a great deal. No sensible man will give credence to that which appears to need such extravagant puffery; and the time has arrived when the discussion of Railroads and Internal Improvement must be rather mathematical than poetical.

Specification of a Patent granted to HENRY MONTAGUE GROVER, *of Boveney, Buckingham, for an intended method of retarding and stopping Railway Trains.* [Enrolled Nov. 2, 1840.]

The "method" here patented, if not an improved, is at least an abundantly "singular" one. From the lower frame of the carriage or truck, a wooden block or box is suspended by a bar link, within about half an inch, more or less, of the wheel; this box contains a large soft iron horse-shoe, enveloped for iron helices for converting into a powerful electro-magnet when its good offices are required. From these helices, wires proceed up into the carriage where a galvanic battery is situated, and with which they can be connected at pleasure. Should any accident or other circumstance render it expedient to retard or stop the train, connecting the wires with the battery, converts the horse-shoe into a powerful magnet, which, hanging within a "striking distance," catches hold of the rim of the iron wheel, pressing itself and the wooden box against it, after the manner of the brakes usually employed. The patentee states that these electro-magnetic brakes may be applied to one or more of the wheels of a train, or the apparatus may be applied to one wheel, and its action transmitted to other wheels by means of levers. We apprehend Mr. Green has greatly underrated the extent of power required to arrest the progress of railway trains, and the electro-magnetic power capable of being obtained by the means he proposes.—*Mech. Mag.*

Specification of a patent granted to WILLIAM PEIRCE, *of James's Place, Hoxton, for improvements in the construction of Locks and Keys.* [Enrolled Nov. 2, 1840.]

These locks, which are upon Barron's principle, with numerous tumblers, are furnished with a detector, consisting of a sliding bolt acted upon by any one or all of the tumblers; the opposite end of this sliding bolt is joinied to a small lever, mounted on a suitable axis. Within a tube, opposite the lower part of the key-hole, a dart, or sharp-edged punch is placed upon a strong spiral spring; there is a notch on the under side of the dart, in which the detector level rests, and holds the dart down upon the

compressed spring. On attempting to open the lock with any but the original key, one or other of the tumblers is over lifted, which, acting on the detector level, releases the dart or punch which flies out through the keyhole, wounding the hand that holds the key. The face of the punch being in the form of a letter or figure, inflicts a wound that for several weeks identifies the aggressor; these locks have therefore been termed *Identifying Detector Locks.*

In order to prevent the accumulation of dirt, &c., within the pipe of the key, a metal stop is fitted so as to work freely within it, being kept flush with the end of the pipe by means of an internal spiral spring, which yields to the pin of the lock when in use.

The claim is,—1st. The mode of constructing detecting locks, 2nd. The mode of applying spring stops to keys.—*Mech. Mag.*

For an *Excavating Machine;* Joseph Hanchett, Coldwater, Branch Co., Michigan, February 28.

"The nature of this invention consists in combining together a common wagon, with a rising and falling frame containing a plough for loosening the earth, and turning the same into the buckets of a revolving vertical wheel placed behind the forward plough, and at the side of another plough; which elevates the earth and deposites it at the side of the excavation, or into a box or receiver on said wagon, or into a cart. Also in shaping the side of the ditch by trail cutters behind; the whole being drawn forward by animal power." The claim is to "the before described combination and arrangement of the elevating wheel, ploughs, adjustable frame, and inclined trail cutters, for excavating and cutting ditches."

This plan will, we are convinced, add another to the many abortive attempts which have been made to construct excavating machines for ditching and embanking, or for loading the excavated earth into carts, or other vehicles. We are aware that there are in operation some very useful machines for excavating, but we do not know of any completely successful effort to accomplish the purposes proposed by that before us. The object is one of great importance, particularly in the prairie regions, and there are several individuals now at work, seeking to obviate the objections to the machines heretofore essayed. We think that they are, in general, aiming at more than they will be able to effect, but doubt not that some valuable improvement will be made in this department of engineering.—*Jour. Frank. Inst.*

Metallic Relief Engraving.—1. Take a tablet of plaster of Paris, and, having heated it, apply wax for absorption to all the faces save that on which you intend your drawing to be, and to that one apply your drawing, executed with lithographic ink, on lithographic transfer paper. Let the side of the tablet on which is the transferred drawing be now dipped in weak acid and water, and then permitted to absorb a solution of sulphate of copper. By electro-metallurgy a deposition of copper can be made on all parts stained with the sulphate. Ere this coating be too thick, let the tablet be removed from the vessel in which this last operation has been carried on, washed *carefully*, dried, and a mixture of isinglass and gin be poured on it; its redundancy be gently blotted off with blotting paper till the surface be level (*i. e.*, the copper lines and isinglass cement be of the same height): again, let the deposition take place, and again its succeeding operation; after which let common black lead be rubbed over the whole surface; and the deposition being removed, a copper mould, from which a type metal block may be subsequently cast, is now formed.

2. Draw with a pen dipped in warm isinglass colored cement, and when your drawing be dry, for an instant expose it to steam, and then coat it with leaf gold. Proceed by electro-metallurgy, as in last method, and no cast is necessary.—*Atheneum.*

Artesian Wells in the Oasis of Thebes.—M. Ayme, a French chemical manufacturer, has been nominated by the Viceroy of Egypt civil and military governor of the whole of the Oasis. This Oasis is 23 leagues in length, and from two to four in breadth. That of Garbe, where there is also an alum manufacture, is about 20 leagues in extent. These two Oases contain, it is said, some excellent soil, calculated for raising indigo, cotton, sugar, and madder; they are studded with Artesian wells, which have been noticed by Arago. The ancient inhabitants used to dig square wells through the superficial vegetable soil, clay, marl, and marly clay, down to the limestone, from 20 to 25 metres in depth. The last rock contains the water which supplies the wells, and is called by the Arabs *Agar el moya.* In the rock, holes were bored from four to eight inches in diameter. These holes were fitted with a block of sandstone supplied with an iron ring, in order to stop the supply, when there was danger of inundating the country.

Wonderful Artesian Well.—At last, after *seven years* assiduous toil and boring, to the depth of 1700 feet! on the 26th February, *M. Mulot*, the engineer, who had persevered against all discouragements in the enterprise, was rewarded, at the moment of withdrawing the iron rod, (as thick as an ordinary axletree,) with a copious gush of warm water. At the sight of it he exclaimed, not unlike the Greeks under Xenophon, on reaching the sea, "Water! water!" and in his working clothes rushed to the Town Hall, where the municipality were in session, and bursting into their midst, repeated "Water! water!" and they in turn cried "Huzza for *Mulot!*"

The site of this remarkable well, which continued to pour forth a full and constant stream, was at the public slaughter-house, near the barrier of *Grenelle.* Mulot was honored with a decoration in consequence of his success. He is to be employed in piercing three other such wells.

Crowds of curious persons had continued to visit the wonder, all carrying away in vials and bottles portions of water, and some shaving themselves in public with the warm fluid. Ministers had also visited it. The water will, it is supposed, suffice for the supply of the neighborhood of Chaillot, of the Military School, and the Invalides. Warm baths for the accommodation of the people are to be constructed and supplied from this source.

Zincing Copper and Brass.—M. Boettiger has succeeded in covering plates and wires of copper, brass, pins, &c., with a brilliant coating of zinc. His method is as follows:—Granulated zinc is prepared by pouring the fused metal into a heated iron mortar, and stirring it rapidly with the pestle until it is solidified. The metal thus granulated is placed in a porcelain capsule, or in some other non-metallic vessel. A saturated solution of sal-ammoniac is poured over it; the mixture is boiled; the objects to be rendered white are now placed in it, previously dipped in dilute hydrochloric acid: in a few minutes they are covered with a brilliant coating of zinc, which it is very difficult to remove by friction. The galvanic action is thus explained:—The double chloride of zinc and ammonium formed is decomposed by the zinc and the plate of copper; the chlorine disengaged from the sal-ammoniac goes to the zinc; the ammonium is disengaged in the form of gas, and the undecomposed sal-ammoniac combines with the

chloride of zinc to form the double chloride, a very soluble and easily decomposed salt. If, then, an excess of zinc exists in the solution in contact with the electro-negative copper, the salt is decomposed into its elements, and the reduced zinc is deposited on the negative copper.—*Atheneum.*

History of Steamboats.—The following facts, which are condensed by the Baltimore Sun from a lecture recently delivered before the Baltimore Mercantile Association, will prove interesting: "In England, although the use of labor saving machinery had begun to be entertained by many ingenious minds, yet its full development was at once stifled by the poor workmen, on the one hand, lest they should lose the means of obtaining bread for their families, and by the alarm which the rich entertained lest the poor thus deprived of employment should be thrown upon them for maintenance. But in America no such retarding motives were in operation. There was work for a hundred hands were there was but one pair of hands to perform it. And this necessity developed the genius of invention for which the people of this country have become so remarkable. The brief history given by the lecturer of various inventions originated or successfully applied in the United States, was highly interesting, and the description of the descent of the first steamboat on the Ohio and Mississippi rivers, during the earthquake of 1811, held the audience in almost breathless attention. The credit of having first applied vertical paddle wheels to the sides of a boat, and for having first constructed a boat upon this principle, Mr. Latrobe contended, should be shared with Mr. Rosevelt and Mr. Stevens; from the former of whom, he thinks, the principle now so successfully applided to steamboats was obtained by Chancellor Livingston and communicated to Mr. Fulton while Mr. Livingston was Minister to France. And had Mr. Fulton delayed but a few weeks his successful trial upon the Hudson, Mr. Stevens would have had all the honor which now attaches to Mr. Fulton, for he was also building a boat on the same principle, and finished it but a few weeks after Robert Fulton's experiment with his boat. The original idea of vertical paddle wheels applied to the centre of a boat is so curious that we will give it as mentioned by the lecturer. Mr. Rosevelt, of New York, the same who built the first steamboat on the western waters, and with his family descended the Ohio and Mississippi, during the fearful earthquake of 1811, while a boy, amusing himself with making and launching tiny vessels, cut out of a shingle the rude form of a boat; across the centre of this he laid a small shaft, which projected over the side of his boat, he attached wheels with four arms, similar to the wind mills which the boys are in the habit of making. Around the shaft he wrapped a piece of twine, and then to the end of the twine attached a bent hickory spring. He then placed his little vessel in the stream, and had the delight to see, that as the spring moved and drew upon the thread and unwound it, the wheels were set in motion and the boat moved forward upon the water. This was some twenty years before Fulton's successful trial upon the Hudson. After this, and before Mr. Fulton was known in this matter, Chancellor Livingston, Mr. Rosevelt, and Mr. Stevens, of Hoboken, were jointly engaged in the endeavor successfully to apply steam to the propelling of boats. The lecturer said that he had in his possession the correspondence which passed between these individuals at the time their experiments were in progress. Mr. Rosevelt wished to apply the wheels vertically, and at the sides; but the Chancellor's idea was that the true principle was in the horizontal wheel, applied to the stern. The latter overruled, and thus the boat was constructed, and put in motion in the bay of New York. It proved to be a failure, as its speed

was only about three miles per hour. The partnership was then abandoned; when Mr. Rosevelt applied his principle to the same boat, and found it to work admirably. But the boat was too weak to bear the central application of power, and was racked so as to be unfit for use. Mr. R. then abandoned the prosecution of the matter for other and more pressing concerns. About this time Mr. Livingston was sent as Minister to France, and there met with Mr. Fulton. Encouraged by Mr. Livingston, the latter made many experiments upon the Seine, not however, with the power applied according to Mr. Rosevelt's idea; but in all he was successful. He finally, in New York, turned his attention to the vertical paddle wheel, centrally applied, and succeeded."

Franklin Railroad.—The Hagerstown Torchlight states that the section of the above road between the Pennsylvania State Line and Hagerstown is completed, and the cars commenced runnig upon it on Wednesday. The occasion was duly celebrated by the citizens of Chambersburg and Hagerstown.—*Baltimore American.*

Quicker Yet.—The new Locomotive, "Owasco," with one passenger car went from Auburn to Syracuse on Thursday last, distance 26 miles, in 52 minutes. This is the quickest trip ever made on the road. The engine was built by Messrs. Dennis, Thomas and Wood of this place, and is superior as a piece of perfect mechanism to any thing we ever have seen.—*Cayuga Tocsin.*

[From the American Repertory.]

ERICKSSON'S PROPELLER.

Steamship Clarion, off Sandy Hook, April 14, 1841.

Capt. J. Erricsson—

Dear Sir:—The following memoranda of time and distance I send you by the pilot, who is now about to leave us.

	h.	m.
Left the Pier No. 1, North River, with a fresh breeze from the S.W., at	2	0
Passed Quarantine, Staten Island, at . . .	3	0
Fort Richmond, a strong flood tide against us all the time, .	3	20
Passed ship Louisiana bound out, under all sail, at . .	3	30
Engine making from 41 to 42 revolutions per minute, and working as smooth as oil. I feel no more jar or annoyance while writing this than you would feel in your room at the Astor.		
Passed buoy off the Upper Middle, at	4	20
Passed beacon on Romer, bearing E.N.E., distance 1-4 mile,	4	30
Sandy Hook light house bearing W., distance 2 miles, and the pilot takes his leave of us, ...	5	00

We have not loosed a sail yet, and have had a fine chance to stow our anchors, &c., and get all ready for sea. I have not time to say more. Yours, &c., E. Dunn,

Comm'r Steamship Clarion.

Capt. J. Erricsson—

Sir:—As it may be interesting to you to learn the success of the steamer Clarion while under my charge, I subjoin the following particulars:

We left Pier No. 1, North River, at 2h. 3m. P.M., and I left the

ship at 4h. 50m., Sandy Hook light bearing west 2 miles. Distance sailed, 21 miles in 2 hours 47 minutes, without canvass, against a head wind and tide, with occasional snow squalls.

Very respectfully, your obedient servant,

JOHN TURNURE, *Pilot.*

New York, April 15, 1841.

The report of the following experiments having been alluded to in our Journal, and the testimony of one party having been given, we proceed to publish all the details, and in a future No. an examination of the subject may be expected.

[From the Journal of the Franklin Institute.]

NOTES OF AN EXPERIMENT WITH LOCOMOTIVE ENGINES. BY GEORGE W. WAISTLER, ESQ., CIV. ENG. W. R. R.

It is the custom to speak and write of locomotive engines in reference to their power almost exclusively; hence we frequently see in the public prints notice of the performances of engines where the extraordinary results (if they be extraordinary) are set forth to show the superior power of the engine, and accompanied too with remarks calculated, if not intended, to lead the reader to believe that the builder, by some invention or peculiar mode of construction of his own, had succeeded in producing a greater effect from the same cause than had heretofore been accomplished.

That one engine may be of superior power to another of course is true; just as true as that one house may be of greater capacity than another, and for the same reason; because it is built to order on a large plan; but it must be equally true that an engine can have no greater power than is *due to the capacity of its boiler to generate steam*, and that the effect produced by this power can be no greater than is *due to the available weight of the engine for adhesion.* Yet it is sometimes stated that the engines of one maker with less available weight (weight on the driving wheels) than those of any other maker, have superior power and will draw much heavier loads.

To those at all acquainted with the present state of the locomotive engines, and the mode of construction pursued by almost all makers, both in this country and in Europe, to whom the causes for effect are obviously of so definite a nature, and so perfectly limited in every case—being subject to order—such statements and assertions seem strange and unaccountable; it is in fact to say that one pound used as a power will produce a greater effect than another pound, or more distinctly, that the gravity of one pound is greater than the gravity of another pound; and it must be attributed to the apparent inutility of contradicting such absurdities that these statements have been permitted to pass unnoticed. But since it is so apparent that few, if any, will take the trouble to investigate and understand the causes and effects in this machine, but rather treat all questions relating to it as matters of veracity, apparently regardless of the absence of all probability or even possibility of such effects from such causes, I am induced to offer the result of a recent

trial on this road of two engines of different makers to ascertain their relative *effective* power.

I am the more induced to this, because I conceive the growing faith in these oft repeated and undenied statements of superior and *peculiar* power, is not only injurious to the builders themselves, but to the true interests of railroad companies.

It is of serious injury to railroad companies, because it induces them, in the expectation of rapid improvements, to limit themselves too closely in their first outfit, and then in the expectation of procuring something of superior and peculiar power, they are induced to go from maker to maker as each may set forth such claims; thus collecting a variety of pattern destructive of that uniformity in the several parts of the engine, which by affording the facility of shifting parts from one to another, or applying parts common to all, is so essential to the economy and despatch of the operations of the road. This variety of pattern and make on any road creates an equal variety of opinion and prejudice among the agents of the road, for and against engines of different makers, equally prejudicial to the maker and the company; when in fact there may not, and among makers of reputation (so far as power is concerned) there is not any other difference than may be the result of the architectural fancy of the builder, sufficient, however, to destroy all uniformity; and I am fully of opinion that this uniformity is of such importance, that all deviations should be avoided until the advantages of a change are of such an obvious nature as to render a total change desirable.

I presume the advantages of this uniformity in the parts of engines cannot be doubted. I have no hesitation in saying (and my experience leads me to it) that a given number of engines with perfect uniformity of parts, permitting the immediate shifting of parts from one to another, will perform more, much more work than the same number equally good in themselves, but all differing from each other, and that there are great advantages, t oo, in having all the engines on one road of the same make, I think, will be admitted, when, wherever this is found to be the case on any road; there you find the engines in the best order, and enjoying the best reputation; and whether this be the effect of the prejudices of those who use them, or their faith and natural pride in the good qualities of *their engines* where all are alike, instead of the variety of opinion, and equally natural prejudice in favor or against engines of particular makers where all are different; the public is there less incommoded, and the company less prejudiced by the delays consequent upon accidents to, or defects in the engines.

Another injurious effect upon railroad companies, and likely to be more serious in its consequences is, that this faith in the superior and *peculiar* power of engines, leads to expectations of almost unlimited effects; at least to such extent that almost any grade could be ascended without the least inconvenience: in short, expectations that could never be realized without some special dispensation of the law of gravity; yet in conformity with these expectations, it is frequently urged that roads should be constructed (with reference to

cheapness) to conform nearly to the natural surface of the ground, regardless of steep grades, since engines had been *invented*, or certainly soon would be, with power to ascend the steepest as easily as they had heretofore on a level—and engineers are not unfrequently placed in the embarrassing predicament to be overwhelmed with *facts and statements!* in relation to the superior and mysterious effects of engines, depriving them of the immutability of nature's law of gravity to found an argument on.

The locomotive is a steam engine of the most simple form, and the general plan of construction pursued by almost all makers is essentially (so far as power is concerned) the same. The boilers, the source of power in all, are similar,* being cylindrical, horizontal and tubular; the only difference being that some have square or rectangular furnaces, and others have circular or rounded furnaces; each, however, being able to generate steam sufficient to overcome the adhesion due to the weight of the engine; indeed, this is understood by all good makers to be a necessary condition, and all that I am acquainted with accomplish it.

The reciprocating motion of the piston is applied directly by means of slides, and a connecting rod to produce a circular motion of the wheels, either by a crank in the wheel axle, or (which is the same) to a pin in the spoke of the wheel; the effect is precisely the same in both, and if the adhesion between the wheel and the rail be greater than the resistance to progressive motion of the engine and train (from friction and gravity) then will the whole advance; but if it be not, and there be steam power sufficient to overcome what adhesion there may be (and all engines have this power) then will the engine and train remain stationary, while the wheels turn round, slipping on the rails; and no additional application of steam power can cause it to advance; to say otherwise would be to say, that if I (*having strength sufficient*) should break a lever in attempting to lift a weight, another, *because he has greater strength*, could lift the weight with the same lever!

Yet this is what the public are made in a great measure to believe by the statements we so frequently see of the extraordinary performances of engines. It must be clear then, that the limit to the power of any locomotive engine to propel trains *is the adhesion of its driving wheels to the rails*, which adhesion is at all times, and under all circumstances, *in proportion to the weight on the driving wheels;* and although this adhesion is not the same (in amount) under all circumstances, varying as it is well known, with the condition of the rails, as effected by the state of the weather, &c.; yet it is *always the same with all engines under the same circumstances;* hence the relative effective power of any two engines—power to propel trains—must be strictly *in proportion to the whole weight on the respective driving wheels of each;* which will be seen to correspond with the result of the trial.

I give you the statement as made at the time, officially, to the

* This is not strictly correct, vertical tubular boilers are used on engines in Maryland to a considerable extent, and various forms have been adopted in England for the boilers of locomotives on both common, and railroads. COM. PUB.

President of the Corporation, for the information of the Board of Directors.

ENGINEERS' OFFICE, WESTERN RAILROAD,
Springfield, August 24th, 1840.

THOMAS B. WALES, ESQ., President W. R. R. Corporation.

DEAR SIR:—In accordance with the leave granted to Mr. Richard Imliy, by vote of the Board of Directors of the 11th of April last, to place an engine on this road for trial, he arrived at our depot here on Thursday afternoon, with a locomotive engine, constructed by Mr. William Norris, of Philadelphia; the engine is of the largest class; on eight wheels, four being drivers of four feet diameter; her cylinders are twelve and a half inches diameter, and length of stroke twenty inches.

It was arranged that the trial should be made next moring with this engine, to ascertain what load she could draw up the plane on this road, next to our depot here; (it being the maximum grade east of the Connecticut river) and also to see if one of the corporation engines could draw up the same plane an equal load in proportion to the weight on its drivers.

The foot of this plane intersects the level through the depot yard about two hundred feet from the passenger house, and rising at the rate of 60 feet per mile for 8,200 feet, then at the rate of 66 feet per mile for 2000 feet, then at the rate of 46 feet per mile for 700 feet, and thence to the top, at the rate of 60 feet per mile, is two and forty-four hundredths miles in length.

The engines being ready with full tenders of wood and water, and steam up, were brought to the platform scales to be weighed: the object being not only to ascertain the whole weight of each engine, but what portion of the whole weight is brought to bear on the driving wheels of each; it is known too, that when the steam is applied to give motion to the engine, the effect is to alter the distribution of the weight of the engine between the forward and driving wheels, relieving the former of a portion of their weight and placing it on the latter. Measures were taken in the weighing to ascertain the extent of this change; this was done by placing each engine, first, with the forward wheels on the platform scales; the tender, being attached to the engine, was chained to the track to prevent the advance of the engine when the steam was let upon the piston, that the effect might be exhibited by the scales; this effect was to relieve the forward wheels of a part of their weight.

The driving wheels were next placed on the platform, the tender chained to the track as before, and the steam applied; the effect was to increase the weight on the driving wheels.

The results of the weighing are as follows:—

Engine "America," built by Norris.

Weight on driving wheels,	17,550 lbs.
Do. forward wheels,	11,590
Total weight of engine,	29,140 lbs.

Weight of Tender, (eight wheeled) wood and water.

Weight on forward truck,	13,050 lbs.
Do. hind truck,	12,870
Total weight of tender,	25,920 lbs.

Weighing under Pressure of Steam.

Weight on forward wheels without steam,	11,590 lbs.
Do. do. do. with steam,	9,650
Difference,	1,940
Weight on driving wheels without steam,	18,620
Do. do. do. with steam,	20,010
Difference,	1,390

After this engine had performed her trip, she was placed again on the platform scales, it having been observed that she worked under higher pressure of steam up the plane than when on the platform at the first weighing; at this weighing the result was as follows:—

Weight on the driving wheels without steam,	19,220
Do. do. do. do. with steam,	21,070
Difference,	1,850

It will be seen that these several weighings differ in their results; this may be attributed, in part, (in the cases where the weights of the same parts of the engine differ when weighed *without* the action of steam) to a different state of the water in the boiler, and to the fact that at the first weighing of the driving wheels, the engineer and fireman were both off the foot board; but I am inclined to believe from the very great difference between the first and last weighing, which last was made with great care, that there must have been some error in reading off the first weight.

The difference in the weights under the pressure of steam may be attributed to the different positions of the cranks at the time of weighing, since the effect would vary from a maximum to nothing, depending upon their position.

Taking the weights, however, as they were recorded.

The first weight of the drivers without steam was	17,550 lbs.
Add weight taken from forward wheels by first weighing with steam,	1,940
Total weight on drivers in operation by first weighing	19,490
Second Weighing.—On drivers with steam,	20,010
Third Weighing.—On drivers with steam,	21,070
	3)60,570
Mean weight on drivers in operation.	20,190

Engine "Suffolk," built at Lowell.

Weight on drivers,	16,150 lbs.
Do. on forward wheels,	7,480
Total weight of engine,	23,630
Tender (four wheeled) wood and water,	14,000

Weighing under Pressure of Steam.

Weight on drivers without steam,	16,075 lbs.
Do. do. with steam,	17,150
Difference,	1,075
Weight on forward wheels without steam,	7,480
Do. do. do. with steam,	5,700
Difference,	1,780

First Weighing.

Weight on drivers without steam,	16,150 lbs.
And weight taken from forward wheels,	1,780
Total weight on drivers in operation, first weighing,	17,930

Second Weighing.

Weight on drivers without steam,	17,150
	2)35,080
Mean weight on drivers in operation,	17,540

The effective weight (weight on the drivers) of the "America," Norris' engine, is 20,190 lbs.
That of the "Suffolk," Lowell, is 17,540

Immediately after the weighing was completed, the "America" was attached to a train, consisting of twenty-seven cars, and started on the level at the foot of the plane within about 400 feet of the plane, commenced ascending with a velocity of about seven miles per hour; ascended about one mile, gradually diminishing the velocity until the adhesion of the drivers being overcome, the wheels slipped, and the train stopped, not being able to proceed further up the plane with the load; returned with the train down the plane to the starting station. Mr. Imly was requested to take such load as he thought the engine would take up the plane at a speed not less than six miles per hour; he detached six cars; started again with twenty-one cars, gross weight, 259,698 lbs.; with this load she ascended the plane, with steadiness to the top in twenty-six minutes, being at the rate of 5.63 miles per hour.

The engine returned again, with this load, to the starting place, when the "Suffolk" (Lowell) was attached to the same train, leaving off four cars, taking seventeen cars, gross weight, 198,042 lbs.; with this load she ascended the plane to the top in 14¾ minutes, being at the rate of 9.92 miles per hour.

It was supposed when this trial was made, that the train would give a load to this engine equal to that taken by the "America," in proportion to their effective weights; but it was found, after weighing the cars, that the load was deficient.

The "Suffolk" was again attached to the train, with nineteen cars; gross weight, 234,218 lbs.; with this load she ascended the plane to its top in 21½ minutes, being at the rate of 6.8 miles per hour.

The whole load of the "America's" train, Tender included, was

Tender,	25,920 lbs.
21 cars,	259,698
Total,	285,618

That of the "Suffolk's" train, Tender included, was

Tender,	14,000
19 cars,	234,218
Total,	248,218

Effective weight of the "America,"	20,190
Do. do. do. "Suffolk,"	17,540

Then $\frac{17,540 \times 885,612}{2,190} = 248,129$ lbs., the load the "Suffolk" should have taken; she did take 248,218 lbs., thus showing that the effect produced by each engine, except in speed, was as it should be, *equal*.

The greater speed of the "Suffolk" is most probably due to the greator diameter of her driving wheels: as the velocity of both trains was such—being small—the difference between them may not have materially effected the resistance.

The engine "Suffolk" is on four wheels, two of which are drivers, four and a half feet diameter. Cylinder twelve inches in diameter, and eighteen inches stroke. Pressure of steam in the boiler, ninety pounds. Pressure of steam in the boiler of the "America," one hundred and thirty pounds.

REPORT OF THE TRIAL OF THE ENGINE AMERICA, FROM BOSTON TO SPRINGFIELD, WEDNESDAY, 19TH AUGUST, 1840.

The undersigned a miniority of the committee appointed to attend the trial of an engine, made by William Norris, Esq., of Philadelphia, and who were also charged with a communication, from George W. Whistler, Esq., respecting the engines and cars required for the railroad west of the Connecticut, respectfully report,—

That on Wednesday, the 19th of August last, an engine made by Mr. Norris, called the "AMERICA," accompanied by an eight wheel tender arrived in Boston, and was attached to a train of thirty seven freight cars taken indiscriminately from those in use, in the Western and Worcester Railroads.

The "Engine" was a beautiful piece of workmanship, encircled by an

iron frame, mounted on eight wheels, with straight axles, outside connections and superior in size to any in use upon the Western Railroad, and her whole appearance was highly creditable to the manufacturer.

The weather was fair, with but little wind, and all the circumstances as favorable to the movement of a heavy load as could be desired.

After some delay occasioned by the detention of some downward trains, the "America" was set in motion, at 53 minutes past 12 M., with the following load attached to her, viz. Tender with wood and water, as weighed at

Springfield,	25,920	lbs.
37 Freight Cars,	154,468	"
Merchandize, viz. Plaister,	235,200	"
80 Bales of Cotton,	32,464	"
235 Casks of Spikes,	34,125	"
	482,177	

or 241 tons 177 lbs.

The net load of merchandize inclusive of the passengers on the engine a little exceeding 151 tons, with this load, the "America," made a very handsome sart from Boston, she passed the first ascending grade of 23 feet to the mile, 1900 feet in extent, at a speed of 1200 feet per minute, and the next grade of 13 feet to the mile extent, 5,850 feet at a speed of 600 per minute, and a grade of $29\frac{3}{4}$ feet, 3,800 feet long, at the rate of 576 feet per minute. After passing several feet of level road and light grades at a speed varying from 1050 to 1344 feet per minute, the train entered upon a grade of 30 feet to the mile extending 13,340 feet at a speed of 1300 per minute and proceeded about one mile upon the straight portion of this grade, gradually reducing speed, to 408 feet per minute, until entering upon a curve of 12 feet radius, the wheels began to slip, and it became necessary to increase the adhesion by the use of sand upon the rail; by the adhesive power thus gained, the "America" surmounted the elavation without stopping, and after considerable detention by various ascending and descending trains, reached Westborough in three hours, and two minutes running time, from Boston, being an average speed of about 10 miles per hour.

Upon entering the new track of the Worcester Railroad at Natick, a passenger car, estimated to weigh 12,000 lbs., and containing about 28 passengers, computed to weigh about 4000 lbs., was attached to the "America," and with the residue of the load, was drawn by her into Worcester, where she arrived with the train at a late hour of night, her power for the last few miles being severely tasked by this addition to the load and a copious dew, which moistened the rails. Although she actually carried this heavy load into Worcester, without aid from any other engine, the undersigned is satisfied that she could not have passed the curve, on the high grades, without the use of sand to increase the adhesion, and that the load was heavier than she could draw over the road against an adverse wind, or in an unfavorable state of the rails, or with a proper degree of speed. In suggesting this, however, he would not disparage the performance of the engine, as it far exceeds anything which has yet been accomplished on the Boston, and Worcester Railroad, 90 tons net weight of merchandize, being the heaviest load yet carried from Boston to Worcester, even with the aid of sand, on any trial of power, and by the annexed statement, marked A, furnished by Major Whistler, it will appear that the Engine "Suffolk," when tried upon the same road, with a view to test her power, carried but 86 tons of goods or about 56 per cent, of the amount moved by the "Ame-

rica,"—And it is also proper to remark, that the freight cars were not in perfect order, several of the wheels, causing an excess of friction by coming in contact with the sides of the cars, and the line of the draft being rather too high for the engine, while the Worcester Road is considered out of line; and there was reason to believe that if the road had been in good order, the "America" could have carried the same load with greater speed, and without the aid of sand, in a train of eight wheel cars, of approved modern construction.

The weather continuing fine, Mr. Imlay, the agent of Mr. Norris, concluded to try the engine on the Western Railroad, with the same train of freight cars and lading she had drawn from Boston, and a single passenger car.

With these she ascended the grade of 42 feet at New Worcester, but stopped at or near the summit, the load being too heavy. At this point the agent detached 5 freight cars, laden with plaister weighing together 58,483 lbs., and a passenger car, leaving the load attached to the "America" 423,624 lbs., of which rather more than 130 tons was merchandise. With this she started upon the grade, and proceeded to Charlton, passing over the summit level, which is the highest point between Boston and Springfield, in a very handsome style. Her time from Clapville to Charlton, $4\frac{1}{2}$ miles, as taken with great care by the undersigned, was 39 minutes over an ascending grade, the entire distance, no part of which, as he is informed, was less than 30 feet, and $2\frac{1}{2}$ miles of which was 48 feet to the mile. Her average speed, from Clappville to Charlton, was $6\frac{3}{4}$ miles per hour, and her lowest rate, near the summit, was about $4\frac{1}{2}$ miles per hour.

Although this performance fell short of the sanguine expectation of Mr. Norris, it was highly creditable to the Engine, and very satisfactory to the miniority of your committee. It demonstrates to his entire satisfaction, that such an engine will carry with ease, from Boston to Springfield, a load exceeding 100 tons of merchandise, as an ordinary daily duty. And he was the more gratified with the performance of the America in passing the Charlton summit, with more than 130 net tons of merchandise, when he recurs to the fact, that our engineer, no longer since than March last, reported to the committee of investigation of the stockholders of this company, that the engines now in use on the Western Road, were competent to draw 59 tons between Boston and Springfield, and have, as he is informed in no instance drawn over 70 tons over the road. And he is satisfied, that we may now assume, as a basis, for estimating the cost of transportation, between Boston and Springfield, that at least 100 tons may be drawn in a train. After passing the high grades, on the Western Railroad, your committee considered their duties performed, and separated, after delegating to Mr. Jackson the office of attending to the weight of the engine, who proceeding to Springfield, and ascertained her weight to be 29,140 lbs., the weight upon her four drivers, when at rest, to be 18,620 lbs.

On the day after the arrival of the "America" and her train at Springfield, and in the absence of all the Committee, except Mr. Jackson, it was proposed to try her on the 66 feet grade, at Springfield, and with one of the Lowell Engines, the "Suffolk." This trial was made, and the result, is given in the annexed report of the Engineer, by which it appears, that the America carried up the plane, including 21 cars and tender, "a load of 285,618 lbs." in 26 minutes, and the "Suffolk" a load of 248,218 lbs. in $21\frac{1}{2}$ minutes, by which it would appear that the "Suffolk" performed as much in proportion to the weight on the drivers as the America, and in less time.

The latter is also reported to have worked with a pressure of 130 lbs. to

the inch, while the Suffolk worked with a pressure of 90. If this experiment, tried in the absence of a majority of the Committee, be a test of their comparative power, it would appear that the America possessed no decided advantage over the Suffolk with respect to power; but the miniority of your committee is not prepared to decide upon a single experiment, which may be, and often is fallacious, where comparisons are instituted and a predilection for one or the other engine may influence the judgment; and he places less reliance on this experiment, inasmuch as the Suffolk performed far more than she had done in her former trials while the America performed less; the load carried by her over the Charlton Summit the day previous being, by a computation made by the miniority of the Committee, equivalent to a load of 340,000 lbs. on the Springfield Plane, over which she carried 285,618 lbs.

The minority of your committee cannot acquiesce in the results or recommendations of Mr. Jackson appended to the report of the majority, considering it altogether unjust to assume as a basis, for the calculation made by him, the weight upon the drivers of the America, after her descent from the Plane, and the weight upon the drivers of the Suffolk, before her ascent. Strict justice required that they should be weighed under the same circumstances.

Neither can he concede that the weight upon the drivers is the sole measure of the power of a locomotive, having satisfied himself that though an important element in furnishing power, its efficacy is materially increased or diminished by the steam power of the engine, the arrangement, and construction of the mechanism, the proportion and adaptation of the parts of the machine, the line of draft, and the mode of applying the power.

With respect to the America, it was apparent that she moved with great ease, both to herself and the road, that her motion being more equal, was less injurious than that of all four wheel engines, both to herself and the rail, while she is less liable to fly the track.

The undersigned has also been informed by the directors of numerous railroads, that the construction of the Norris Engine is far less complicated than that of the Lowell Engine, and that, of course, they are far less liable to expensive repairs, and when injured, are more easily repaired. And it is important to remark that the repairs of our locomotives consume a large portion of the profits of our railroads. And he would consider it altogether impolitic upon a road which must require a large number of engines, to order more until a thorough investigation has been made into their comparative merits. To determine with accuracy the relative powers of the "Lowell" and "Norris" Engines, further trials must be requisite.

And these trials and further inquiries are also requisite, to show their comparative consumption of fuel and other qualities, among which the minority of your committee consider a liability to expensive repairs or freedom from such liability, most material. And he is led to dwell more particularly on this subject, because he is informed that the average expense of keeping the Lowell Engines in repair, on the Eastern Railroad, is at least $15,00 per annum, while Mr. Norris will guarantee his for $500 each per year.

He would, therefore, recommend the trial of farther experiments, and would particularly recommend that a load of 100 tons of merchandise in 30 cars be provided at Worcoster, and the same be drawn from Worcester to Charlton on the same day by the Suffolk and America, and that an accurate account be kept of the time and fuel consumed by each; and before

leaving this subject, he would remark that it would be doing injustice to the Suffolk, did he not say that her performance on the Springfield Plane was highly creditable to her, and indicates that she may possibly draw a much larger load over the Charlton summit than was originally anticipated. With respect to the other subject confided to your committee, the report of Major Whistler respecting the engine and cars required for the route west of the Connecticut, he would unite with the majority in reporting, that it is expedient to order four eight-wheel passenger cars, as recommended by Major Whistler, and would farther recommend that two of these cars be provided with water closets, and saloon for ladies, and that all be furnished with the vibrating plates in use on the railroads in the Middle States.

With respect to the freight cars, the minority of your Committee has made diligent inquiry, and has ascertained that the four wheel freight car is now gradually going out of use, and it is generally regarded in Pennsylvania, Maryland, and the Southern States, as much inferior to the eight wheel freight car.

The principal objections made upon our road to the eight wheel freight cars, are two. First, that they may be too large for the amount forwarded to the way depots. Second, that they require more labor to move them at the different stations.

With respect to the first objection, he would remark, that we already have at least single freight cars, which seems to be a liberal provision for the side depots, where little business is transacted, while the business at these depots, is increasing, and must continue to increase.

With respect to the second objection, he believes that it arises from the clumsy and defective construction of the few double cars in use in this section of the country, which has disaffected the operatives at the depots, and if these objections could not be easily obviated, the double cars are reported to have such decided advantages, that they are entitled to a preference. A good car of this description will carry from 10 to 12 tons of merchandise, with less jar and injury to the freight than a single one; is more convenient for stowage; will conform to the curves of the road, diminish the length of the trains, and the resistance of the wind, and do least injury to the track, will also be safer, and less liable to fly the track. He would, therefore, recommend that the committee and engineer be requested to procure from Pennsylvania, or Maryland, a double car of the most approved construction, and an order to be given to our manufacturers here to make 19 more to correspond.

With respect to the engines to be used west of the river, it should be borne in mind, that we shall doubtless have occasion for a considerable length of time to use 15 miles of the track of the Hudson and Berkshire Road, the flat bar rail of which is entirely inadequate to sustain a four wheel engine with 4 tons on each driver, and if we should order engines similar to those in use east of the Connecticut, they could not pass from Pittsfield to Albany. As the number upon our road will beincreased by the addition of two new engines from Lowell, and during the coming winter, it is not probable that more than one train per day will be required between Springfield and Chester, they would respectfully recommend that no more engines be ordered until farther experiments have been made, and farther information obtained, as to the costs of repairs.

All which is respectfully submitted by

(Signed) E. Hasket Derby.

A Minority of the Committee.

ON THE PRINCIPLES OF ELECTRO-MAGNETIC MACHINES.

Professor Jacobi, of St. Petersburg, infers, from his experiments, the following laws in reference to the magnetism developed by the application of the galvanic current.

1. The amount of magnetism produced in malleable iron by a galvanic current is proportioned to the force of the current.

2. The thickness of the wire composing a helix, and surrounding an iron rod, is of no consequence, provided the number of turns of the helix, and the force of the current, remain the same. With thin wires, however, a more powerful galvanic battery must be used, in order to overcome the resistance in the conductors.

3. Generally, in practice, the influence of the coil may be neglected.

4. The total action of the electro-magnetic helix upon the iron rod, or core, is equal to the sum of the effects produced by each coil separately.

5. The maximum of magnetic effect is obtained from a galvanic current, when the total resistance of the conducting wire, which forms the helix, is equal to the total resistance of the battery.

6. When the diameter of the iron cylinder forming the core of the helix is increased, the length remaining the same, the force of magnetism developed by a given current is increased in the same proportion.

7. A variation in the length of the core only influences the result by admitting a greater number of turns of the helix upon it.

8. The attraction of electro-magnets is proportional to the square of the force of the galvanic current, by which they are formed.

In the last trials made in propelling a boat twenty-eight feet long, seven and a half wide, and drawing two feet and three quarters of water, on the Neva, a velocity of three miles an hour was kept up. The boat carried twelve to fourteen persons. Professor Jacobi remarks that this is the velocity attained by the first steamboat.

In reference to the practical application of electro-magnetic power, Professor Jacobi gives the following rules. 1st. The maximum of mechanical effect is proportional to the square of the number of voltaic elements, multiplied by the square of the electromotive force, and divided by the resistance of the voltaic circuit. The co-efficient by which these values must be multiplied to give the effect, depends upon the quality of the iron forming the electromagnets, the form and arrangement of the rods, and the distance between their ends. A battery of platinum and zinc plates produces two or three times the effect of a similar one of copper and zinc. 2nd. The force of the machine varying directly as the square of the number of coils in the helix, and the velocity inversely as the same square, the maximum power is independent of this number. It is also independent of the dimensions of the electro-magnetic rods. 3rd. The attractive force of the electro-magnets, or pressure of the machine is proportional to the square of the force of the current. 4th. The economic effect, or the available power divided

by the consumption of zinc, is expressed by the relation between the electro-motive force and the co-efficient spoken of under the first head. 5th., The consumption of zinc while the machine is at rest is double that when producing the maximum effect.

Professor Jacobi concludes his remarks thus:—

"I consider that there will not be much difficulty in determining with sufficient precision the duty of one pound of zinc, by its transformation into the sulphate, in the same manner that in the steam engine, the duty of one bushel of coal serves as a measure to estimate the effect of different combinations.* The future use and application of electro-magnetic machines appears to me quite certain, especially as the mere trials and vague ideas which have hitherto prevailed in the construction of these machines, have now at length yielded to the precise and definite laws which are conformable to the general laws which nature is accstomed to observe with strictness whenever the question of effects and their causes arise. In viewing, on the other hand, a chemical effect, the intermediate term scarcely presents itself. In its present case, it is magnetic electricity, the admirable discovery of Faraday, which we should consider as the regulating power, or, as it may be styled, the logic of electro-magnetic machines."

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* It may be recollected by our readers that we pointed out a method by which the expense of working an electro-magnetic engine might be estimated in our article upon that subject, published in 1839. It is gratifying to find that men of science are pointing to this as the true method to ascertain the real progress of the invention. That the "duty" may be ascertained from the same data is but a consequence of the positions of Prof. Jacobi.

A PROSPECTIVE VIEW OF PENNSYLAANIA IN RELATION TO HER SYSTEM OF INTERNAL IMPROVEMENTS, WITH SPECIAL REGARD TO THE PROPOSED PHILADELPHIA AND PITTSBURG RAILROAD.—*No.* 2.

The natural advantages which have decided the location of commercial cities, and have administered to their growth and prosperity, it is true will always continue to operate in their favor. The easier access of Baltimore to the sea constitutes one of its natural superiorities over Philadelphia. But, on the other hand, we must admit, on the authority of experience, that such natural advantages may, in a very considerable degree, be counterbalanced, first, by the influence of superior capital, and secondly by the effect of artificial communications.

Steamships may reach as readily the port of Philadelphia as the port of Baltimore, or other commercial places, and we can by means of railroads form all the connection with the interior we may desire.

Let us now look into the merits of the proposed route for a continuous railroad from Philadelphia to Pittsburgh, and examine what its prospects are when compared with rival routes.

The distance by the Baltimore and Ohio railroad from Baltimore to Pittsburg, according to the last report of the engineers on that work, will be three hundred and forty miles. There are numerous steep grades upon that line, particularly in the mountain section. There occurs on the east-

ern slope of the Alleghany mountain a grade of sixty-six feet per mile of twenty-two miles in length. A similar steep grade will occupy the western slope, but only to a small extent. There are also steep gradients and short curves between Harper's Ferry and Baltimore.

Now, according to the report of the engineer, the distance from Harrisburg to Pittsburg, by the preferred route, called the middle route, which runs up the valley of the Juniata and Little Juniata, and ascends by the slopse of the latter stream the summit of the Alleghany mountain, thence descends to Ebensburg, and pursuing the valley of the Black Lick, crosses the Conemaugh river below Blairsville, and continues in a very direct course through the county of Westmoreland, and by the valley of the Monongahela, finally reaches Pittsburg. The whole distance by this route is two hundred and forty-two miles, and adding to it the distance from Philadelphia to Harrisburg, of one hundred and sixty miles, we have the total distance from Philadelphia to Pittsburg, three hundred and forty-eight miles, with no grades exceeding forty-five feet per mile, and but a very moderate proportion of curvature.

We understand, however, from a private conversation with the Engineer, that there are reasons to believe that a farther saving of distance of about ten miles may be effected by more minute surveys, and thus the whole distance would be reduced to three hundred and thirty-eight miles, two miles less in distance than the line from Baltimore to Pittsburg. But we all know, that in comparing two lines of railroad, we have to consider the gradients as well as the distance.

The total rise and fall on the Philadelphia and Pittsburg line will be considerably less than on the Baltimore and Ohio line, and the grades on the former route are not as variable as on the latter. Thus it is established by the Engineers that the virtual distance from Baltimore to Pittsburg will be greater than from Philadelphia to Pittsburg, and that, therefore, Philadelphia can compete successfully with Baltimore in the advantageous transportation of goods and passengers to the west, vice versa.

Now let us turn our attention to New York. This commercial emporium has been aroused from its lethargy by the efforts of Boston in forming a continuous railroad communication to the lakes, and is now actively engaged in prosecuting with vigor the New York and Erie Railroad and the New York and Albany Railroad, and the good earnest which they show in this cause, leaves little doubt that these two lines will be completed at an early period.

It is stated by Mr. Schlatter, that when Cleveland on Lake Erie, is taken as the western termination of the different routes, the distance from New York to Cleveland by the New York and Erie Railroad, and thence by the Lake, is 654 miles. The distance from Cleveland to Pittsburg by railroad is estimated at one hundred and thirty miles, which makes the total distance from Philadelphia to Cleveland four hundred and seventy-eight miles, therefore one hundred and seventy-six miles less than from New York to Cleveland. At the same time, it should be remembered that the grades upon the New York and Erie Railroad will be less favorable than upon the Philadelphia and Pittsburg Railroad.

The nearest route from New York to Phiadelphia is eighty-five miles. Add to this four hundred and seventy-eight miles, and we have the total distance from New York to Cleveland, via Philadelphia and Pittsburg, five hundred and sixty-five miles, therefore ninety-one miles less than the distance by the New York and Erie Railroad.

What inferences are we to draw from these important facts? Nothing han that, in the natural course of things, when a continuous line of rail-

road shall be establihsed from Piladelphia to Cleveland, via Pittsburg, the New York merchants will send their goods to the west by way of Philadelphia, and that the Philadelphia merchants who import their goods directly, will have a decided advantage over those of New York.

The construction of a railroad from Pittsburg to Cleveland, will, there is no doubt, be undertaken as soon as the Harrisburg and Pittsburg Railroad is commenced. But even before that work should be completed, the conveyance of goods and passengers from Pittsburg to Cleveland can be effected by the Beaver Division Cross Cut and Ohio Canal at an increase of distance of about twenty-five miles.

We should therefore bear in mind that the transportation of goods and passengers by railroad from the east to the Ohio river and the lakes, will chiefly take place upon the Philadelphia and Pittsburg Railroad. New York cannot help, in this respect, to pay a heavy tribute to Philadelphia. Thus the citizens of our metropolis will have it in their power to control a very large amount of the western trade, *if they choose, and are willing to do their duty.*

The reason why Cleveland is taken as a point for the lake trade, is obvious. The harbor of that city is open at an earlier period than all the other ports on the lake. Railroad lines are in comtemplation from Cleveland farther west, and we shall eventually have a continuous line from Philadelphia to Chicago and to the Mississippi.

When the town of Erie is assumed as the terminus of different rival routes, and we suppose a branch of the Philadelphia and Pittsburg Railroad should leave the main line at the mouth of the Black Lick, and thence following the Kiskeminetas and ascending by the Buffaloe Creek, and following the direction to Franklin and Meadville, terminate at Erie, then the total distance from Philadelphia to Erie by this route is estimated at about four hundred and eighty miles, which estimate will not be far from the truth.

On the other hand, the length of the New York and Erie Railroad is four hundred and eighty-four miles. Adding to this the fifty miles distance from Dunkirk, (which is the termination of the New York and Erie line,) to the town of Erie, we have five hundred and thirty-four miles as the total distance from New York to the latter place, via New York and Erie Railroad.

The difference of distance in favor of the Philadelphia route over the New York route would therefore be fifty-four miles.

Considerations of so vast importance should certainly not be trifled with; they deserve to be carefully weighed in order that we may be enabled to arrive at sound conclusions. We should not leave to chance what we have in our power by well directed efforts to control.

The city of Boston is trying her utmost to complete a continuous line of railroad to the lakes, and another year will have accomplished this gigantic undertaking.

The distance from Boston to Albany by the Worcester and the Western Railroad will be two hundred miles. The distance from Albany to Buffalo and thence to Cleveland is five hundred and twenty-five miles, which makes the total distance from Boston to Cleveland seven hundred and twenty-eight miles, or two hundred and fifty miles more than from Philadelphia to Cleveland. Boston therefore cannot begin to compete with Philadelphia for the Cleveland and far western trade. Is this not also a strong argument in favor of establishing a line of steamers between Philadelphia and Europe? Is Philadelphia determined to become paralyzed by the energetic efforts of her neighbors, and this, too without even making an effort

to compete? The tendency of the present age is evidently progressive. While we are surrounded on all sides by active vigor and intellect we cannot pause to reflect, *but we must go on*, and reflect while on our march.

REPORT OF ELLWOOD MORRIS, CHIEF ENGINEER OF THE CHESAPEAKE AND OHIO CANAL.

CHESAPEAKE AND OHIO CANALLINE,
December 31*st*, 1840.

(Concluded from our last No.)

Some curiosity having been expressed with regard to the probable detention at, and the mode of transit through the tunnel, I propose, before dismissing this subject, to dwell briefly upon both.

The canal for some distance both in approaching and leaving the tunnel, has from economical considerations been planned with a single boatway, as follows:

	Feet.
Canal contracted to a single boatway adjacent to the south portal,	200
Tunnel, (in length)	3118
Canal contracted to a single boatway adjacent to the north portal,	894
Total length of canal contracted to a single boatway,	4212

The speed of loaded boats upon canals is usually taken at $2\frac{1}{2}$ miles per hour, and this may be considered as the maximum pace of fully freighted boats. Owing to the contraction of the waterway and other causes in the tunnel, the progress of boats in their transit through will be slower than upon the open canal, and will not probably exceed the rate of $2\frac{1}{4}$ miles per hour, or 198 feet per minute.

A single passage through a lock of 8 feet may be practically regarded as requiring upon an average 5 minutes, and an alternate or cross passage of two boats 10 minutes.

Hence with single locks (which case only I shall here consider) if the canal were working at its utmost capacity, it would, upon the supposition of uniform motion, bear upon its bosom during the season of trade, an ascending and a descending procession of boats moving at intervals of 10 minutes apart, passing each other alternately, and locking in alternation: consequently 12 boats, or 6 proceeding in each direction, would pass a fixed point during every hour.

Having thus premised, I will observe that it is so evident that in order to save time, boats must pass the tunnel in convoys of several, that it is unnecessary to establish that fact in calculation; the only question is how many boats ought each convoy to consist of when the canal is working at its maximum rate with single locks, and consequently when boats are successively arriving at both portals, at intervals of 10 minutes apart?

The answer is—that the proper number will depend directly upon the time requisite to move twice through the contracted canal and draw out past a waiting convoy, or in fact directly upon double the length of the single boatway and convoy in waiting.

For the sake of brevity, I will assume the length necessary to accommodate a waiting convoy at 1200 feet; then as this convoy, by lying along the beam side, would contract the canal to a single boatway for that distance, we shall have:

	Feet.
Length of tunnel and canal constructed to a single boatway,	4212

Length of convoy in waiting, (and also contracting the canal)	1200
Total length of single boatway in effect,	5412

Now to traverse 5412 feet, *twice*, or 10,824 feet, at our assumed pace of $2\frac{1}{4}$ miles per hour, or 198 ft. per minute, would require 55 minutes, and allowing 5 minutes for starting the convoys at both ends and for lost time, we shall have as the period occupied in a double transit, 60 minutes.

To prevent meeting, evidently no boats can be permitted to enter either portal from the moment a convoy in one direction leaves, until the returning one moving in the other has drawn out of the tunnel; hence if we imagine a boat to arrive at one portal the instant a convoy has departed, she would be compelled to wait 60 minutes before her time for passage, as the leader of the next convoy would arrive: during this space of time 6 boats would collect, and that is the proper maximum number for a convoy to pass this tunnel upon the hypothesis assumed.

If the canal had double locks, the convoy should consist of 11 or 12 boats, and the passages still be hourly. Boats then ought to be passed through this tunnel both ways *at every hour*, and with an active trade it would be necessary to have a superintendent stationed at each portal to regulate the hourly transits, and perhaps also to provide gates or some other barrier under his control, to be opened *hourly* to admit the entrance and exit of convoys.

The hours fixed for the transit of convoys both ways should be regularly notified to the boatmen in print—thus:

Descending convoys will leave the south portal of the tunnel at 8 A. M.; 9 A M.; 10 A. M; &c.

Ascending convoys will leave the north portal of the tunnel at $8\frac{1}{2}$ A. M.; $9\frac{1}{2}$ A. M.; $10\frac{1}{2}$ A. M.; &c.

All boats presenting themselves for passage, to conform strictly to the instructions of the tunnel superintendents, and haul into such positions as they may indicate. If boats should arrive at either portal when no convoy was forming at the other, and no boats thence in sight, a system of signals could easily be concerted to communicate that fact, and the arriving boat in such case be allowed by the superintendent to proceed without any delay.

It is evident from what has been said that the utmost detention that any boat can experience will be 60 minutes, whilst a boat arriving just as a convoy in the same direction was setting out, would join its rear, and not be detained at all; hence the average detention may be assumed at thirty minutes, which enables us to ascertain the real or effective saving in distance caused by the adoption of the tunnel route for the canal, in lieu of that located around the Pawpaw Bends.

	Miles.
A canal around the Pawpaw Bends would be in lentgh,	$6\frac{1}{2}$
The tunnel line (including cuts, &c.) is, to the same points,	$1\frac{1}{2}$
The saving in measured distance being	5

Now, during the 30 minutes average detention, a boat proceeding at the rate of $2\frac{1}{2}$ miles per hour, would move upon the open canal $1\frac{1}{4}$ miles; therefore, the virtual saving of distance produced by the tunnel route, when equated by the average loss of time is, 5 miles minus $1\frac{1}{4}$ miles or $3\frac{3}{4}$ miles* saved in effect.

* Strictly the virtual saving would be a little less, owing to the greater speed upon the open canal.

Such are the theoretical results upon a fixed hypothesis, that establish the limits of this subject, which of course in pratice will be modified by many causes; and I will now dismiss the matter with the observation, that though the deductions in this connection might be both more briefly and vigorously developed by mathematical formula, yet I have preferred the more familiar explanations given above as best suited to the present purpose.

* * * * * * *

Summary of the Locks and Levels on the 50 Miles.

No. of Level below Cumberland.	No. of Lock and Level above George Town.	Lift of Lock.	Length of Level.		REMARKS.
		Feet.	Miles.	Feet.	
1	75	10	8	4282	From the 75th to the 72d Level, inclusive, the chief part of the Masonry is now finished.
2	74	10	0	850	
3	73	9	0	579	
4	72	9	1	145	
5	71	8	6	4867	
6	70	8	0	1708	
7	69	8	0	1405	
8	68	8.258	1	3052	From the 71st to the 58th Level, inclusive, the Masonry is exceedingly backward, being in fact scarcely begun.
9	67	8	3	702	
10	66	now converted into 4 Locks each, of 10 ft. = 40 Lockage.	7	513	
11	65				
12	64		0		
13	63			1638	
14	62				
15	61	8	1	1916	
16	60	8	3	1807	
17	59	8	3	681	
18	58	8	2	2524	
19	57	8	4	3562	From the 57th to the 54th Level, inclusive, the Masonry is well advanced, and the most of it is now finished.
20	56	7.7	2	5264	
21	55	7.8	2	789	
22	54	7.8	0	600	
Total Lift and Length,		181.558	49	5204	Distance 50 miles nearly.

* * * * * * *

There is another question involving grave considerations of cost and utility, which ought now to be presented to the directory; it is that of Feeders.

Before entering upon this subject, however, candor obliges me to admit, that the disposable time I have had to devote to this matter, has proved insufficient for the acquisition of sufficient instrumental data, to enable a final decision to be formed upon the merits of all the rival plans which present themselves and command our attention: indeed all that I can promise myself upon this occasion—with regard to such as possess equal merit—is to indicate the direction in which further examinations ought to be made: though it is true, that to some of the plans of feeding, such insuperable and manifest objections exist, that we may venture to reject them, without any further evidence.

By gauging the north branch of the Potomac, above Cumberland, and also Wills' Creek, during an extraordinary drought (September, 1838,) it was ascertained that the quantity of water then running in these streams was as follows:

	Cubic feet.
In the north branch, 19.6-10 cubic feet, per second, or per minute,	1176
In Wills' Creek, 3.6-10 ditto per minute,	216
Total running supply per minute, entering the pool of the Cumberland dam, in September, 1838,	1392

The above gauge of the north branch, though taken with much care, was made by transverse sections and average velocities, upon an uneven site; it may, therefore, possibly err in deficiency: still, with a reasonable allowance for error, it indicates that the supply of water at Cumberland will be, in very dry reasons, entirely inadequate even to supply the natural consumption of the canal, without providing for the lockage of the trade.

This will more clearly appear, by considering the probable wants of the canal, *exclusive of lockage:* to arrive at a proximate valuation of which we must recur to experience elsewhere.

With this view I have compiled the following table, from a report of Frederick C. Mills, Esq., chief engineer of the Gennessee Valley Canal, made to the canal commissioners of New York, under date of January 23d, 1840, wherein he gives a general summary of those practical examinations which have induced the ablest engineers in that quarter to adopt as the measure of the loss of water upon canals, from every source of consumption (except lockage,) the rate of 100 cubic ft. per mile and per minute.

TABLE,

Compiled from the Report of F. C. Mills, Esq., Chief Engineer of the Gennessee Valley Canal, New York, 1840.

Consumption of Water upon finished Canals in New York—caused by evaporation, filtration, and the leakage and waste at the mechanical structures, as ascertained by the following Civil Engineers:—

AUTHORITIES.	Canal experimented upon.	Length of the part tested in miles.	Total consumption, exclusive of lockage, in cubic feet, per mile and per minute.
Judge Roberts,	Erie,	61	90.16
Ditto,	do.	11	100
Ditto,	do.	69½	116.54
Ditto,	do.	141½	103.18
Judge Bates,	do.	79	101.26
Ditto,	do.	20	105
W. H. Talcott,	Chenango,	22	107
3 different Engineers,	2 Canals,	404	723.14

Average of all the experiments, 103 7-10.

Mr. Mills further states that,

"Mr. Talcott's experiments show the loss on 22 miles of the Chenango canal to be 107 cubic feet per mile per minute; of which 66 cubic feet was for evaporation and filtration, and 41 cubic feet for leakage and waste at the mechanical structures; and by using those results as the basis of the calculations on the Gennessee Valley Canal, he makes the loss for the same causes 106 cubic feet: this small difference is owing to there being a less number of mechanical structures on the latter than on the former canal."

The experiments referred to above were made in 1839, and having been undertaken with the express view of acquiring data upon which to found

an accurate calculation of the probable wants of the Gennessee Valley canal on $31\frac{1}{2}$ miles of its length, which is to be supplied chiefly from reservoirs—being in fact designed to guide the expenditure of a large sum of money in such works, they no doubt received all that care and attention which an important object demanded, and which justifies an entire reliance upon Mr. Talcott's results.

Some persons may flatter themselves with the hope, that the consumption of water upon the Chesapeake and Ohio Canal may possibly be less than the above quotations would indicate: for my own part, the investigations of the skilful and experienced engineers of New York, verified as they have been by practice, command my confidence, and induce me without hesitation to assume, that this canal, like others elsewhere, will need, besides its lockage water, a supply from every feeder, equivalent to 100 cubic feet per minute, for every mile of distance fed.

To introduce an intermediate feeder from the Potomac, into the canal, between the mouth of the south branch and Cumberland, would, as the work has been planned, be impracticable without great expense; after passing Evitt's creek there, the neighborhood of the mouth of the South Branch is the first place where a further supply of water can be introduced.

From Cumberland to the South Branch, by the line of the canal, is near $19\frac{1}{2}$ miles; this then is the distance to be fed from the drainage of the valley of the North branch.

Let us now consider the probable amount of water required for lockage; the whole of which, for the thorough trade, must be supplied from the 75th, or Cumberland level; and for this I shall assume the number of boats plying each day upon the canal near Cumberland at 120, (the same number adopted by the U. S. Engineers:) 60 being supposed to arrive and 60 to depart each day, their lockages being assumed to take place independently, and not by the "alternate passage."* These boats, if of 75 tons, would be competent to carry downward, during the navigable season, one million of tons, and would draw from the Cumberland dam per day, for lockage 120 times the prism of lift of lock, No. 75, of which, in the face of a probable deficiency of water, I find, with surprise, the lift to be established at 10 feet, the maximum in use upon the canal.

Lockage water required for the assumed trade.

$100 \times 15 \times 10 \times 120 = 1{,}800{,}000$ cubic feet per day, or 1,250 cubic feet per minute.

Consequently, with such a trade, the wants of the canal from Cumberland to the South Branch, would require, to satisfy every cause of consumption, the following uniform supply of water:

	Cubic feet.
Per minute for lockage, at 120 locks full per day,	1,250
Per minute, for all other sources of loss upon $19\frac{1}{2}$ miles, at 100 cubic feet per mile and per minute,	1,950
Demand of the canal per minute,	3,200
Supply of running water entering the Cumberland dam in the driest seasons (as before stated) per minute,	1,392
Deficiency per minute, during extreme droughts,	1,808

It is proper to remark that we are dealing with extremes in this connection; for in ordinary seasons I doubt not that the supply of water at Cum-

* This assumption is made in order to cover the maximum expense of water, though I doubt not that during an active trade many "alternate passages" would be made.

berland will be enough to enable a moderate use of the canal, as low down as the South Branch. It is only in droughts that it would so completely fail to supply the trade. And if it be asked how, upon such occasions, this prodigious dry weather deficiency is to be made up? the answer is, only by reservoirs upon Evitt's or Wills' creek, or both: for to introduce Evitt's creek as an ordinary feeder, whereby 432 cubic feet per minute might possibly be added to the supply, would not reach the root of the evil, and would still, in dry weather, leave a large deficiency unprovided for.

It would, however, be prudent policy to defer the construction of any of these auxiliary works, until, by the opening of the canal, its exact consumption (clear of lockage) can be ascertained by actual experiment.

The probable deficiency of water in the North Branch at Cumberland, to supply the consumption of the canal and the lockage of the trade upon 19½ miles, or in dry seasons even the consumption alone upon that length of canal, indicates most clearly that unless the traffic upon this work is to be left, like the navigation of the river, dependant upon the clouds, an intermediate feeder between Cumberland and dam No. 6, will (to make the improvement perfect) be indispensable, even at the very first opening of the navigation of the new canal; and accordingly, whenever the directors are prepared to extend their operations, the *intermediate feeder* ought, in this view, to be one of the very first works let: for the idea of putting the canal into complete use through the medium of the Cumberland dam alone, must, it seems to me, in the face of the facts set forth, be necessarily abandoned: though a considerable Spring and Autumn trade might be thus maintained.

* * * * * *

3—*On the Condition and Prospects of the Finished Canal, now Navigated 134 Miles Upstream from Georgetown to Dam No.* 6.

It is gratifying to be able to state that upon the finished part of the canal during the past year, breaches have been less frequent than heretofore; thus indicating that the stability of the Banks is gradually augmenting by time, and the continual strengthening of weak points by repair, as fast as they display themselves by leaks or breaches.

The 4th division, being the 27½ miles next below dam No. 6, (with the exception of that work proving more leaky than was expected.) has during the past year fully retained its reputation for fidelity of construction, the navigation for the time it was open having, like that of last year, remained entirely uninterrupted; it must however be remarked that this division has never yet been tested by a full head of water. The costly improvements upon this part of the line made during this year, at the pool four miles below Hancock, and in the limestone district near Prateas Neck have (I understand) thus far answered the expectations which were formed of their utility.

The two extensive pools upon the 4th division, at Mrs. Bevans', 4 miles below Hancock, and at Fort Frederick below Licking Creek, especially the latter, will need additions to their embankments to enable them to carry safely 5 feet water; the banks should receive more internal base, be augmented in height, and armed upon their faces with a Riprap; the superintendent of the 4th division has been injudiciously directing his attention to these points.

The necessity of elevating the Towpath Bank of the Fort Frederick Pool, and protecting its interior face with rock, will be gathered from a mere statement of the fact that it is about 2 miles long in a right line and 20 feet deep or more, giving manifestly both scope and depth enough to enable a heavy gale of wind to create a sea, which I apprehend deeply

freighted canal boats will sometimes find it difficult to weather: these surges rushing with violence against the towpath, would evidently breach it very soon, if not provided with a suitable defence.

Every objection which can be properly urged against River Slackwater Pools, (except current) lies with much greater force against that at Fort Frederick, because the latter runs in a straight line, and is therefore liable to be swept by gales from end to end; whereas a river pool is almost always land locked by its own curvature, it being a rare instance in which the wind would have a fair sweep over 2 miles lineal of water where the depth at the same time approximated to 20 feet; even the very trees which fringe a river bank would shield the pool to leeward: and it is a well known fact that a gale of wind, to raise formidable waves, must have both free range of surface and depth of water to operate upon; for depth is necessary for the action of those peculiar oscillations which form waves, and scope is requisite to give time for the rushing air to draw the particles of water into motion.

There is, however, another important advantage which pools within a canal must always possess over a river slack water, and this is, that the level of the canal water remaining fixed, the towpath of course is never liable to overflow.

A vicious plan of taking earth for repairs from places already weak, (merely because the land happens to belong to the company,) has occasionally upon sudden emergencies been practised—indeed necessarily so—by the superintendents.

The remedy for this is plain: the company ought at suitable points upon the beam side of the canal, to acquire by purchase small lots of ground, whence earth could be conveniently taken for repairs; and as a general rule, no material should ever be excavated for that purpose between the canal and the river, for in addition to the earth in such places being less accessible, its removal has a direct tendency to weaken the earth works of the canal.

So prodigious is the leakage of dam No. 4, 5 and 6, in their present imperfectly gravelled state, that during the past summer the water in their pools subsided so far below their respective combs, that for several weeks it was impossible to introduce more than about 18 inches depth of water over the mitre sills of the Guard Locks, though their gates were thrown wide open for the purpose.

Of course the navigation upon the feeder levels of these dams could not be maintained, and was necessarily suspended for some time. This result was not unexpected at dams No. 4 and 5, but certainly unlooked for at dam No. 6, which, having been built in a much more careful and costly manner, it was reasonable to expect it to be more retentive of water.

Candor, however, requires the remark, that neither of these dams have ever yet been gravelled to a necessary extent, which, if properly done, ought to prevent leakage sufficiently, and which I would respectfully advise, should be completely done at the earliest practicable period, as the annual exposure of the dams to the summer's sun must, of necessity, cause *the rot* to destroy them with great rapidity.

Under present circumstances, the leaks in each of these dams seem to be just about sufficient to pass under a head of 15 feet, the entire summer flow of the the Potomac during a dry season leaving 5 feet of the crest of each work exposed for some weeks in almost every year. This indicates dam No. 6 to be the tightest of the three, as the river is considerably smaller at its site than it is at the locations of others.

The heavy ice freshet of February, 1840, made a large breach in dam No. 4, which has been successfully repaired during the summer and autumn, by the superintendent of the 3d division; who has also replaced a large portion of the down stream sheathing (which had been injured) with 6 inch plank, which will be a decided improvement, as the old 3 inch sheathing was entirely too light to withstand the tremendous reaction of drift which the figure of the dam causes to take place during freshets with extraordinary violence, both here and at dam No. 5. Indeed it remains to be seen whether even the 6 inch sheathing will prove entirely successful in resisting those assaults which a radical defect in the figure of the overfall profile necessarily produces.

It was to have been expected that the maintenance of dams of sufficient dimensions and extent to bridle a river so formidable during freshets, and rapid in its downward course from the mountains, would be expensive: it will not therefore be a disappointment to know that the day is not far distant when both dams No. 4 and 5 will need extensive repairs; and this period has not been a little hastened by the summer exposure before alluded to. Whenever these large repairs are made, which ought to be taken in hand in time, I would recommend that the profile of those works should be altered, so that the overfall may be nearly perpendicular, which will destroy the reaction that now takes place during floods.

The experience of the last few years indicates, in a decided manner, that the traffic of the country bordering upon the Potomac, or what may be called the "*way trade,*" will be able to pay all the expenses of the company and keep the canal in repair. This is a very satisfactory prospect, as it will leave the tolls upon the *thorough trade* from Cumberland, to enter the treasury of the company unencumbered by charges; and hence all the revenue so derived will be clear profit.

With the view of elucidating some of the subjects treated in this report, I addressed a few interrogatories to the four Superintendents of finished canal, which, with the responses of those officers, I have embodied for the information of the Directors, in the following tabular statement. (See next page.)

As it appears from this table (and from my own knowledge) that never more than 4 to $4\frac{1}{2}$ feet water has yet been maintained in the 4th Division, and as from its costly and careful construction we have a right to expect that it will better carry 5 feet water than any part of the canal, I accordingly respectfully advise that the Superintendent of the 4th Division be instructed, upon the opening of the navigation in 1841, or soon thereafter, to put up all the levels between Dams No. 5 and 6, to the full depth of "*five feet,*" and to maintain that depth during the navigable season.

I had intended to have gone carefully over the finished work, and personally examined every part of it in a thorough manner, previous to making this report; but a want of sufficient time upon the present occasion absolutely precluded me from putting that purpose into execution, and has compelled me to content myself with furnishing much more meagre information concerning the finished canal, than had been either designed or wished.

In conclusion, I may observe generally of the 134 miles of canal now navigable, that with trifling exceptions, *its condition is good, and its prospects satisfactory.*

All which is respectfully submitted by

Your most obedient servant,

Ellwood Morris,

Chief Engineer.

STATEMENT.

No.	QUERIES BY THE ENGINEER. Substance.	John Y. Young, Sup. of the 1st Division, answers:	Wm. O'Neall, Sup. of the 2d Division, answers:	John D. Grove, Sup. of the 3d Division, answers:	Joseph Hollman, Sup. of the 4th Division, answers:
1	What average depth was maintained in your levels during the past seasons?	5 to 6 feet.	4 1-2 to 6 feet.	4 1-2 to 5 feet.	4 1-2 feet.
2	Were embankment breaches more or less frequent this year than heretofore?	Less frequent.	Only one branch since I came into office.	Less frequent.	Neither leak nor breach has occurred this year.
3	Does your division annually become stronger?	The weak parts having been strengthened gradually, I answer yes.	Yes.	Yes.	Yes, except the two large pools.
4	Are the mechanical structures upon your division now in good repair?	Yes: the lock gates having been renewed. The wooden bridges are in bad order.	Yes, except lock gates.	Yes, except lock gates.	Yes, all.
5	Would all the levels of your division now bear "five feet" depth of water?	Yes, with safety.	Yes, with a small outlay upon banks.	Yes, I think so.	Yes, with safety, except the two large pools.
6	Will the revenue of the present fiscal year, ending May 31st, 1841, exceed or fall short of that of the last fiscal year?	Probably exceed that of last year.	Unable to form an opinion.	I think it will be near the same as last year.	Probably exceed that of last year.
7	Is your division now in good repair or not?	Yes, generally.	It is in good repair.	It is in good repair.	It is in good repair except those pools.